all over the state. Imagine the chaotic conditions we could expect if our snowplows never did get on the road; or, if for some reason all traffic stopped, even for a single day. No mail, no food, no visiting, no living would be the result. Our Department and its functions are indeed extremely newsworthy activities.

The Public Relations Section news releases are forwarded to 4 daily papers in this state and to 4 metropolitan newspapers in nearby states. Copy is provided regularly for weekly newspapers, 10 radio stations, and 8 magazines. A total of 331 news releases were issued during the past year, in many cases with photographs. Many other news releases were issued to individual papers for local news. Other news releases appeared a number of times in trade magazines of national circulation. The photographic laboratory supplied the pictures to accompany the news releases. The photographic personnel also showed films and slides about the Department's work on dirt roads and beach protection work at the request of local civic organizations.

A complete photographic record is maintained for the Department of construction work, existing conditions, right-of-way problems, experimentation, and tests.

II. ACTIVITIES OF THE ENGINEERING SECTION

PLANNING AND DESIGN DIVISION

The Planning and Design Division coordinates the activities of the Road Design Section, the Bridge Section, the Right-of-Way Section, the Planning Section, and the Utilities Section with the other sections of the Department which are concerned with any aspect of contract plan preparation.

Upon completion of the plans they are assembled with proposals, special provisions, right-of-way agreements, and other factual information which are then forwarded to the Federal Aid Section.

Road Design Section. The Road Design Section designs, reviews and approves all plans for road construction on Interstate, Primary, Secondary, and Tertiary roads. Consulting engineering firms engaged for certain projects work with the Road Design Section.

Tables III, IV, and V show various categories of projects processed through this Section.

TABLE III
CONTRACTS AWARDED
July 1, 1960 — June 30, 1961

Contract Number	Description	Type	County	Mileage	Bid Price
I-1, (21)-1, I-1 (23), I-1 (24)	The Christina River Interchange	Interstate	N.C.	1.873	$12,977,428.99
1833	South Union St. Connection	New Construction	N.C.	0.182	189,881.43
1925	Long Bridge	Reconstruction	N.C.	0.262	83,385.10
1820	Claymont School Streets	"	N.C.	0.598	79,651.00
1821	Poplar & Spruce Avenue, Elsmere	"	N.C.	0.321	39,558.00
1728	Harmony Road	"	N.C.	0.384	71,681.00
1779	Tuxedo Park	"	N.C.	1.352	151,190.70
1740-1	Haven Lake Bridges	"	K. & S.	0.015	245,997.00
1780	Central Avenue, Ocean View	"	S.	0.596	49,987.50
1807	Lea Boulevard	Widening and Resurfacing	N.C.	0.566	60,539.50
1984	Pearson Corner to Marydel	Resurfacing	K.	6.200	206,102.00
1985	Hartly to Kenton	"	K.	4.320	139,708.00
1863	Dirt Roads	Reconstruction	K.	8.900	191,905.00
1870	Dirt Roads	"	S.	10.860	190,905.00
1865	Dirt Roads	"	S.	11.220	158,240.00
1882	Dirt Roads	"	S.	7.340	139,963.00
1884	Dirt Roads	"	S.	7.150	135,219.00
1885	Dirt Roads	"	S.	5.460	78,263.00
1886	Dirt Roads	"	S.	4.440	61,135.00
		TOTALS		72.039	**$15,250,663.22**

TABLE IV
CONTRACTS, DESIGN COMPLETE
July 31, 1960 — June 30, 1961

Contract Number	Description	Type	County	Mileage	Bid Price
1924	Road 306 at Vernon	New Construction	K.	0.101	$ 11,700.00
1567	Washington Street Ext.	Reconstruction	N.C.	1.485	668,000.00
1568	New Castle Avenue	"	N.C.	1.406	817,000.00
1637	Center Road	"	N.C.	0.819	583,000.00
1654	Moores Lane	"	N.C.	2.067	485,000.00
1674	Faulkland Road	"	N.C.	1.139	430,000.00
1683	Foulk Road	"	N.C.	2.769	1,070,000.00
1745	Indian Field	"	N.C.	1.090	111,000.00
1746	Highland Woods	"	N.C.	0.920	90,000.00
1793	Rt. 7 (U.S. 40 to Rt. 273)	"	N.C.	1.920	287,000.00
1847	Cranston Heights	"	N.C.	0.420	37,000.00
1876	Airport Road	"	N.C.	1.190	260,300.00
1823	South Little Creek Road	"	K.	1.620	96,000.00
1850	Intersection Alterations	"	K.	0.088	57,000.00
1740	Milford By-Pass, Walnut Street Ext.	"	K. & S.	3.867	1,010,000.00
1524	Rt. 14 (Fenwick Island to Bethany Beach)	"	S.	5.173	700,000.00
1563	Rt. 14 (Indian River Inlet to Dewey Beach)	"	S.	6.202	1,250,000.00
1808	Road 249	"	S.	4.426	168,000.00
1809	Road 549	"	S.	3.393	112,000.00
1447	Wyoming to Willow Grove	Widening and Resurfacing	K.	5.519	474,000.00
1694	Millsboro to Hardscrabble	"	S.	9.661	380,000.00
1827	Double Bridges to Redden	"	S.	4.204	190,000.00
	Dirt Roads	Surfacing	N.C.		
			K. & S.	137.320	2,472,000.00
1835	Cleland Heights	Drainage	N.C.		59,000.00
		TOTALS		196.799	$11,818,000.00

TABLE V
CONTRACTS UNDER DESIGN
July 31, 1960 — June 30, 1961

Contract Number	Description	Type	County	Mileage
1733	Rt. 40—Christina River (Grading & Paving)	New Construction	N.C.	1.587
1812	Rt. 40 Interchange	"	N.C.	0.739
1813	Bridge over Rt. 356	"	N.C.	0.076
1814	Bridge over Muddy Run	"	N.C.	
1815	Rd. 385 Overpass	"	N.C.	0.313
1816	Christina River to FAI-1 (Grading & Paving)	"	N.C.	0.795
1840	Merging Lane U.S. 13	"	N.C.	0.173
1811	Lebanon Road	"	K.	
1670	County Rd. 588 to Owens	"	S.	5.195
1731	Milford By-Pass	"	S.	3.600
1599	Limestone Road	Reconstruction	N.C.	1.235
1682	Weldin Road	"	N.C.	
1698	Stanton to Churchman Road	"	N.C.	
1732	Rt. 2 (Maryland Line to Newark)	"	N.C.	
1770	Foulk Road	"	N.C.	1.820
1778	Road 411	"	N.C.	1.310
1816	New Bridge	"	N.C.	0.511
1846	Belvidere	"	N.C.	2.200
1851	Rt. 896 (Maryland Line to Newark)	"	N.C.	3.094
1857	Limestone Road	"	N.C.	4.657
1879	Barley Mill Road	"	N.C.	
1623	Millsboro Streets	"	S.	0.981
1767	Stein Highway	"	S.	0.372
1795	Rt. 404 and Rt. 18	"	S.	6.595
1799	County Road 546	"	S.	2.619
1905	Kirkwood Highway Crossovers	"	N.C.	
1632	South Heald Street	Resurfacing	N.C.	0.609
1983	Red Lion to Bear Station	"	N.C.	1.540

The Road Design Section performs the statutory duties of the Department relative to the acceptance of suburban streets into the maintenance system. The laws relate to the construction of new streets and the reconstruction of existing streets.

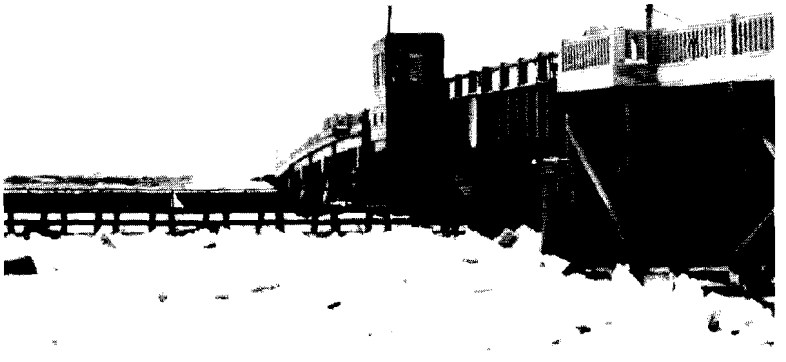
In 1935 approximately 90 miles of suburban streets were accepted from the jurisdiction of the Levy Courts. There was no appreciable increase until 1949, when the total mileage maintained was 100 miles. Since 1949 the population of the State has increased by 148,160, and in the same period the mileage of suburban streets maintained has increased by approximately 305 miles, bringing the total to 405.142 miles. Table VI shows in detail the mileage of streets accepted this year.

TABLE VI
STREETS ACCEPTED IN FISCAL YEAR 1961

Means	Development	Mileage
HB256	Alban Park	0.218
HB256	Albertson Park	0.228
HB256	Anglesey	0.461
SB387	Atkins Addition (S)	0.081
HB256	Brandywine Springs Manor	0.585
HB256	Briar Park (K)	0.059
HB256	Brookside Park	0.074
HB256	Claymont Heights	0.030
HB256	Concord Hills	0.320
SB387	Concord Manor	0.063
HB256	Coventry	1.231
HB256	Fairfield Farms (K)	0.157
HB256	Faulkland Heights	0.592
SB387	Fenwick Island (S)	0.873
HB256	Forest Hills Park	0.274
HB256	Foulk Woods	1.290
HB256	Glendale	0.212
SB387	Gordon Heights	0.062
HB256	Gordon Heights	0.331
HB256	Graylyn Crest, Sect. 3	3,647
HB256	Craylyn Crest, Sect. 4	0.636
HB256	Hillside Heights	0.460
HB256	Industrial Park	0.297
HB256	Jefferson Farms	1.123
HB256	Manette Heights	0.247
HB256	Meadowood, Sect. 1	1.654
HB256	Meadowood, Sect. 2	0.634
HB256	Oakmont	0.152
HB256	Pinecrest	0.639
HB256	Radnor Green	0.085
HB256	Rodney Village (K)	0.428

Continued

Bridge on south-bound lanes of US 13 over Drawyers Creek. Failure of concrete due to intermittent wetting and drying through tidal action and the chemical action of marsh waters.



Charles W. Cullen Bridge at Indian River Inlet, showing the severe ice gorge which threatened destruction of the bridge.

TABLE VI—Continued

HB256	Rogers Manor	0.256
HB256	Shady Lane (K)	0.186
HB256	Shellburne	0.394
HB256	Shipley Heights	0.123
HB256	Smallwood	0.068
HB256	Todd Estates, Sect. 4	1.058
HB256	Tybrook	0.946
HB256	Welshire	0.609
HB256	West Park	0.530
HB256	Westview III	0.084
HB256	Wilmington Manor	0.142
HB256	Windy Bush	0.076
HB256	Wycliffe	0.790
	TOTAL MILEAGE ACCEPTED	22.405
	TOTAL MILEAGE MAINTAINED TO DATE	433.142

Bridge Section. The work of the Bridge Section during the year consisted largely of the design of needed work which could be advertised promptly when finances permitted.

This advance planning proved worthwhile for, with a staff reduced by death and resignations, it was possible in the Spring of 1961 to advertise ten projects and complete plans for sixteen others.

Inspection of the 36-year-old Drawyers Creek Bridge on the southbound lanes of US 13 revealed the fact that the action of the tidal marsh waters had caused such disintegration of the concrete in the piling, between the extreme low- and high-tide limits, the bridge was considered unsafe and was therefore placed out of service.

Intermittent wetting and drying through tidal action and the chemical action of marsh waters make all concrete exposed to such action subject to similar failure. Any concrete structure over tidal waters in this State requires constant inspection and maintenance.

Plans are now being made for a new bridge for the southbound lanes over Drawyers Creek on an improved alignment; however, pending completion of such construction, the existing bridge will be restored to service for single-lane traffic by strengthening its supports.

The past winter was one of the most severe on record. On February 3, 1961, after the breakup of the ice in lower Delaware River and Bay, the combined effect of an easterly

wind and incoming tide caused a severe ice gorge at the Indian River Inlet Bridge.

Due to the effect the tremendous pressures might have when exerted on the north approach spans of the bridge, now carried on wooden piling, the bridge was placed out of service until each individual timber pile had been given an underwater inspection by a diver; this work was performed during the winter weather under most adverse conditions. With the exception of some deep cuts, which did not affect the strength of the piling, no damage was incurred and the bridge was restored to service. The Department has approved the construction of a new high-level fixed bridge to replace the present swing bridge at Indian River Inlet. The present bridge has been limited to a gross weight load per vehicle of 15 tons due to severe corrosion of the steel superstructure.

In the Spring of 1961 the slips for the new all-steel, cable-guided Woodland Ferry were placed in service for the "Virginia C," which replaced the old "Patty Cannon." The new ferry has become very popular. Since its inauguration on April 15, 1961, it had made 1,627 trips, carrying 3,215 vehicles by the end of the fiscal year.

Beach erosion projects are also under the direction and supervision of the Bridge Section. One of the beach restoration projects undertaken during the past year was at Bethany Beach, where some 21,500 cubic yards of sand was used to fill in one section of the beach. A total of 110,000 yards was required, but due to the delay in finding a source of satisfactory sand, it was necessary to suspend the work prior to the vacation season. This project is expected to be completed next Fall.

The Bridge Section, primarily concerned with design, is frequently called on by the county divisions and the Construction Section for advice in field work. The following tabulation shows some of the activities of this section during the past year.

Bethany Beach. Beach restoration work.

Bethany Beach. Beach restoration work.

PROJECTS WORKED ON BY BRIDGE SECTION DURING FISCAL YEAR 1960-61

State Contract No.	DESCRIPTION
MC-34	Little Creek Impoundment, Kent County (Mosquito Control Project).
1533	North duPont Road Bridge over Reading Co. Tracks, New Castle County.
1683	Foulk Road, New Castle County.
1740-1	Haven Lake Bridges on Milford By-Pass, Sussex County.
1757	Replacement of Carpenters Bridge N. 35A on Road 35 over Murderkill River, Kent County.
1763	Replacement of Bridge No. 14, Road No. 221 and No. 8 on Road No. 222, New Castle County.
1777	Replacement of Dirickson Creek Bridge No. 438 on Road No. 382, Sussex County.
1795	State Route 404 and 18—U.S. 13 to Cokesbury. Church, Sussex County.
1829	Double Bridges to Redden, Sussex County.
1833	South Union Street Connection, City of Wilmington.
1842	Kitts Hummock and S. Bowers Beach, Beach restoration, Kent County.
1860	Replacement of Voshells Pond, Bridge No. 360A on Road No. 360, Kent County.
1861	Replacement of Bridge No. 326 on Road No. 364 and No. 345 on Road No. 367 over Christina River, New Castle County.
1871	Bethany Beach Fill, Sussex County.
1877	Upper Nanticoke River, Footing Protection at Bridges No. 129 on Road No. 40 and No. 131 on Road No. 600. Tax Ditch Deepening (Soil Conservation Project) Sussex County.
1889	Broadkill River Bridge Route 14 Repairs and Painting, Sussex County.
1890	Replacement of Bridge No. 679 on Road No. 317, over Wood Branch, Sussex County.
1906	Replacement of Bridge No. 100A on Road No. 100, Kent County.
1925	Replacement of Bridge No. 457 on Road No. 30, "Long Bridge", in New Castle County.
1927	Replacement of Bridge No. 158A, Road No. 158, 162B on Road No. 162,203A on Road No. 203,Kent County.
2000	Coursey's Pond, Raising Spillway, Kent County (Fish & Game Commission project).
2018	Matthes Avenue Bridge Repairs, New Castle County.
2019	Drawyers Creek Bridge Repairs, New Castle County.
2025	Third Street Bridge Repairs, Christina River, City of Wilmington.

Continued

Interstate Bridges

I-1 (21) 1	Bridge Nos. 6-3 and 6-5 and culvert 6-22 on Northbound Route No. 41, Basin Road over FAI-1, New Castle County.
I-1 (7)	Bridges Nos. 4 and 5, Farnhurst Interchange, New Castle County.
I-1 (8)	Bridge No. 6 Farnhurst Interchange, New Castle County.
I-1 (9)	Bridges Nos. 7E, 7W, Ramp B, 8E & 8W, New Castle County, Farnhurst Interchange.
I-1 (10)	Bridge No. 9, Farnhurst Interchange, New Castle County.

Right-of-Way Section. The highway system must be continuously improved by the reconstruction of existing roads or the construction of new highways, thus land is needed in order to serve the needs of the public.

The same legislative act that created the Highway Department and defined its duties also provided the right to acquire land where it is necessary to carry out those duties; however, the same law establishes procedures and protections for the property owner. Trained engineers, planners, and consultants spend many hours in research, planning and designing, consultation and review, to decide where new highways should be located. The final decision is not a hasty one; it is made only after a thorough and objective examination of all the pertinent facts and circumstances. After a project has been approved the Right-of-Way Section procures the land required.

To standardize its procedures, the Right-of-Way Section follows the procedures required by the U. S. Bureau of Public Roads whether the project is to be financed through Federal-Aid monies or not. This adaptation of Public Roads procedures to all State projects necessitated major changes in negotiation procedures and has resulted in better-documented records. Appraisals of each parcel of land are made and approved before being assigned to the individual right-of-way agents for negotiation.

During the year the major portion of the work of the Right-of-Way Section dealt with the acquisition of easements and land for dirt roads. Lands adjacent to dirt roads are obtained through easements, without cost to the State, where more width is required to improve the road. Damages are paid for crops, timber, and manmade structures above or below ground level. However, monies are paid for property and easements which are needed for new alignment or land

which is needed to improve visibility at intersections. Generally, however, unless easements can be obtained without cost the project will not be constructed.

The Right-of-Way Section is continuing to purchase property for the Freeway alignment in Wilmington. Activity has been restricted because of a lack of funds; however, the extent of past purchases can be seen readily by the demolition work which has been done.

Where projects have funds provided the Right-of-Way Section has been active in purchasing the needed lands.

During the past year the Right-of-Way Section has completed the following work:

569 options executed

446 easements executed

227 deeds executed

110 releases executed

72 ditch agreements executed

35 trespass agreements

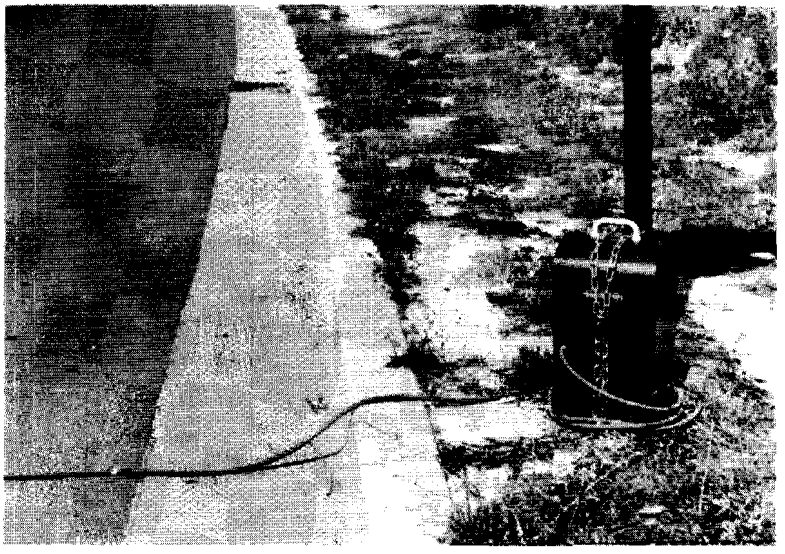
206 descriptions written

Planning Section. The increase in population and motor vehicles, the expansion of the highway system, new legislation, and other factors brought about the need for increased planning studies. During the past year the following compilations and studies have been made; some of these are annual studies and some have been made only as the need for them arose.

1. Annual loadometer study.
2. Annual road inventory.
3. Road life study.
4. Bridge inventory.
5. Railroad grade crossing protection study.
6. Road sufficiency.
7. Economic impact study.
8. Vehicle classification.

Intersection at Milltown Road and Gap Pike before reconstruction.

Intersection at Milltown Road and Gap Pike after reconstruction.



Portable traffic counter in operation. Pneumatic pressure activates the counter when cars drive across the tubing.

Origin and Destination Studies. Through standard interviews with drivers information can be obtained regarding the origin and destination of traffic. This permits highway engineers to properly locate proposed roads and plan for future improvements.

9. A financial study regarding the use of the motor fuel tax.

10. Highway needs study.

11. Research relative to toll roads and interstate highways.

12. Official highway maps.

13. Miscellaneous graphs, charts, and other visual aids.

Public utilities being moved in preparation for work on Milltown Road, New Castle County.

Utilities Section. It is estimated that the number of households in Delaware has increased by 45,000 since 1949. This increase is reflected as well in the number of commercial and industrial establishments. Thus it has been necessary that utilities continually revise their existing facilities for water, gas, sanitary sewers, and electricity.

The Supreme Court of Delaware rendered a decision in January 1961 as follows:

> Today the different utility facilities are used on practically all highways. In many congested areas the question could well be asked: Where else could they go? These facilities are for the benefit of all the people in the communities

which they serve. They provide communication, transportation of heat, light, and fuel. For all practical purposes they are in a sense almost as important to the well-being of those who reside in the communities served by them as the transportation of individuals. Certainly, they now constitute one of the important purposes for which highways are constructed and should be recognized and treated as such.

This is the principle of multiple use of land.

The recent Corps of Engineers report on the Delaware River Basin emphasizes the fact that there will not be enough land to serve all purposes individually and, where possible, land should serve multiple uses. This theory is the combined thinking of the many governmental agencies which participated in a survey costing over several million dollars, thus, in the above presentations we see the future trends.

Utility use of the right-of-way is allowed by State statutes, subject to the rules and regulations of the Department, and is the responsibility of the Utilities Section. The phenomenal growth of Delaware is reflected in the number of franchise permissions which were granted for utility use of highway rights-of-way. During the past fiscal year 400 franchises were granted, which equals the number granted between July 1, 1935 and June 30, 1947. The 1961 population was 461,089 and the projected population for Delaware in 1980 is 856,700; hence the growth of utility facilities should expand at a greater rate in the future than has occurred in the past.

The installation of utilities is expensive, and while the work is being done the public is sometimes inconvenienced. Cooperation between the utility companies and the Department results in savings and decreases the inconvenience to the public, who pay the ultimate cost directly in service charges or indirectly in taxes.

Conferences are held to review projects which are being designed so as to avoid conflicts which may occur during construction and to avoid installing inadequate facilities which would have to be replaced soon after the project is completed. By this procedure major economies can be effected, resulting in sizable savings to the taxpayer.

Preconstruction meetings are conducted by Department representatives and are attended by representatives of all the private concerns interested in the project: contractors, subcontractors, utility managers, etc. At the conference it is attempted to arrange a schedule of operations which will involve the least conflict to mutual progress. By this proce-

dure more economies can be effected, again benefiting the taxpayer.

The Utilities Section is responsible also for determining and approving the extent, nature, and cost of utility adjustment work which is legally reimbursable to utility organizations from public funds.

OPERATIONS DIVISION

The Operations Division coordinates the activities of the Traffic Section, the Construction Section, the Material and Research Section, and the Maintenance and Equipment Section. These sections are closely aligned with the county divisions whose primary functions are the supervision of contract construction and maintenance.

It is the responsibility of the Operations Division to supervise the construction, completion, and future maintenance of the highway system.

Traffic Section. Each year the Traffic Section is receiving more requests for assistance in traffic engineering. Throughout the year representatives of the Traffic Section have held conferences with educational, commercial, civic, municipal, fraternal, and other groups to discuss all phases of the safety problem. Close liaison is maintained with the Delaware State Police, the Delaware Safety Council, and industrial safety committees.

As a result of the rapid growth of population and industry, many existing highway facilities are taxed beyond the capacities for which they were designed. For problem areas the Traffic Section prepares studies evolving corrective measures needed to protect and assist the public. These studies include the redesigning of intersections, the channelizing of traffic, and designing and installing traffic signals appropriate to the local traffic conditions. These studies are prepared in the form of reports and resolutions for approval by the Department.

Each traffic signal must be designed to fulfill a special condition. There are 200 traffic signals maintained by the Department throughout the State: 150 are in heavily-populated New Castle County, 29 are in Kent County, and 21 are in Sussex County. The Department owns 177 of these signals,

8 are jointly owned with local towns and cities, and 15 are owned by industrial plants.

Painted traffic guidance lines are proving to be a valuable safety feature; three types are used. Listed below is an account of the types of lines and the extent of their use.

Painted Guidance Lines

	1959-60 Miles	1960-61 Miles
White center lines	790	1,195
Yellow barrier lines	45	240
White edge lines	32	137
Total	867	1,572

Other types of pavement markings include crosswalks, school signs, warning signs, road markings for railroad crossings, and stop lines and barricades at intersections where heavy traffic necessitates precautionary measures.

Safety signs and signals also suffer vehicle accident damage, and such damage is paid for by those responsible. Payments from 98 individuals last year amounted to $4,637.71.

The increase in population, vehicles, and traffic requires more signs for traffic guidance and destination purposes. An inventory dated October 1960 lists the following signs.

Sign Inventory

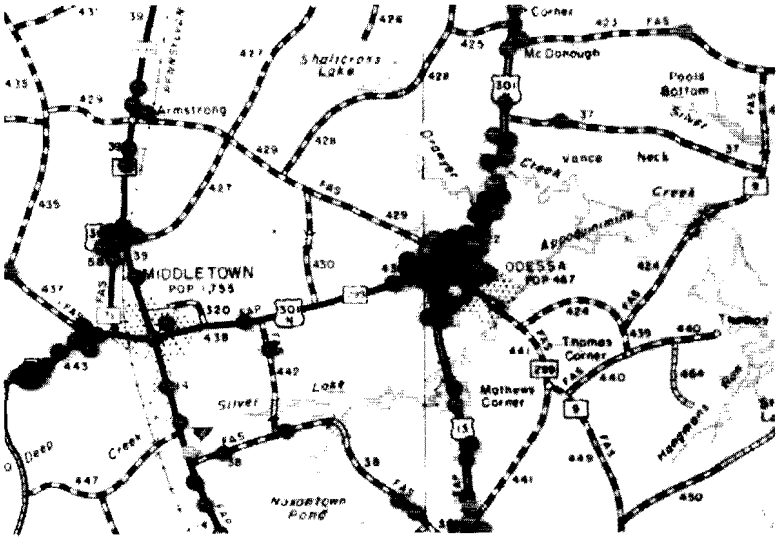
Type of Sign	Rural Highways	Suburban Developments	Total
Stop and Yield	4,265	1,613	5,878
Speed	4,582	410	4,992
Warning	10,847	500	11,347
Destination	2,936	...	2,936
Others	11,679	1,304	12,983
Reflectors	9,903	...	9,903
Totals	44,212	3,827	48,039

Before any regulatory sign, other than for speed limits, can be installed, a description of the requirement and location is prepared in the form of a resolution and submitted to the Department for approval.

Painting green traffic control lines and safety island at State Road, intersection of US 13 and US 40.

Machine for painting lines on the roadway.

Sign at entrance to Delaware.



Traffic Section maintains detailed maps of accident locations.

Construction Section. The principal function of the Construction Section is to assure that all projects under contract are built in accordance with the plans, specifications, and contract documents. This responsibility begins when the contract is awarded and ends upon the final payment of monies to the contractor. (The relationship of the Construction Section is readily apparent in the organization chart presented early in this report.)

Between these limits the personnel of the Construction Section attend preconstruction meetings to insure proper coordination of all construction activities, review all progress estimates, coordinate all contract inspection and procedure to promote uniformity of work, check all work orders before submission to the Department, seek approval of the Bureau of Public Roads for changes in plans or specifications, make final field inspections, and prepare letters to the Department recommeding final payment.

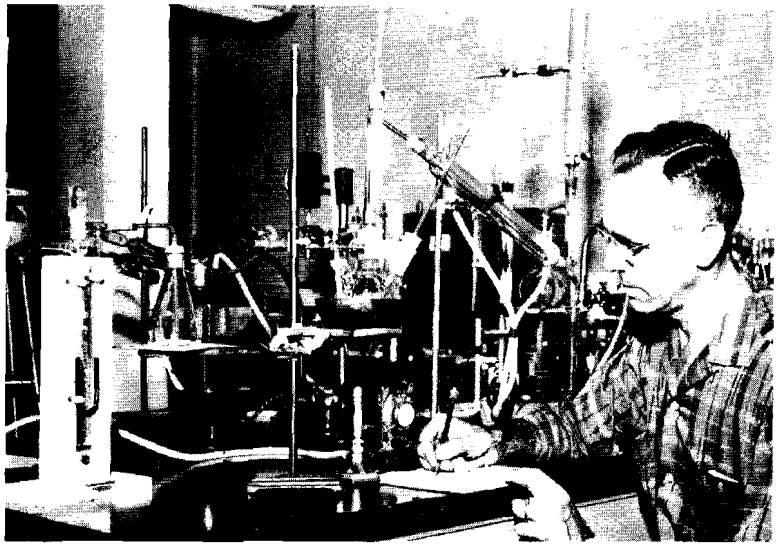
During the past year 297 estimates were processed, representing a total value of $7,744,098.27. Thirty-nine projects were accepted, some of which were started in previous years. There are 41 projects now under construction or not yet accepted by the Department.

Materials and Research Section. The primary function of this Section is to inspect and test all materials used in the construction and maintenance of roads, bridges, etc., and to insure that these materials meet the requirements of the specifications applicable to the various projects. This Section also acts in an advisory capacity to the rest of the Department and to other State agencies requiring such assistance.

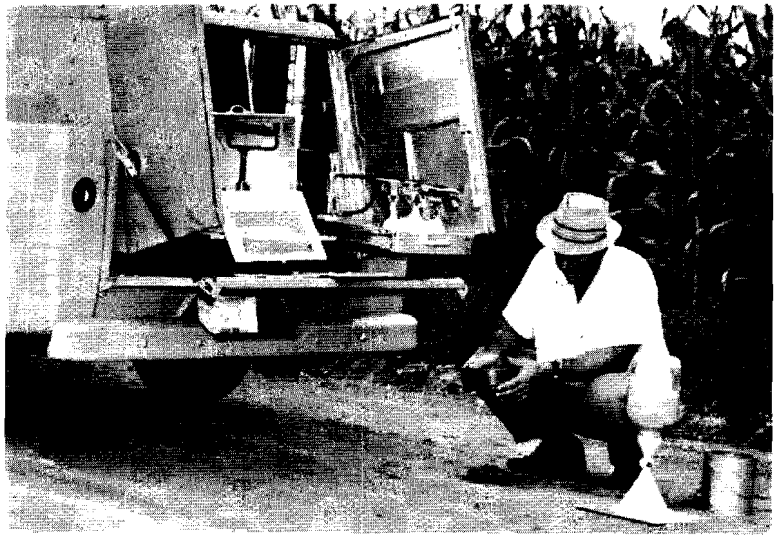
Typical examples of assistance to other State agencies are: for the Motor Vehicle Division, tests of glass used in automobiles; for the State Police Division, tests of gasolines; and for the Mosquito Control Division, various tests on chemicals.

This Section maintains continuous contact with other testing and research organizations, professional societies, and other state highway departments. Such activity keeps the Department abreast of developments in research and construction techniques and also contributes our portion to the general fund of knowledge.

The Testing Section has made considerable progress in research in the fields of hot mix design, the properties of asphalt, and in the testing of beams. The following tabulation



Laboratory technician takes notes on an asphalt test.



Soil compaction test being performed on a secondary road base course.

shows the number of individual quality control tests conducted in the laboratory during the past fiscal year.

Type Test or Material Tested	Number of Tests	Type Test or Material Tested	Number of Tests
Asphalt	1,817	Scales, concrete	65
Marshall stability	1,755	Slump, concrete	510
Scales, asphalt	51	Coarse aggregate	838
Cores	1,828	6" x 12" cylinders	2,963
Plant gradations: hot bin	2,180	Flexure test, beams	160
stock	387	Nucell compression tests	35
Specific gravity, asphalt	176	Steel reinforcing	28
Cubic-foot test	127	Fine aggregate	242
Asphalt stripping test	213	Specific gravity, aggregates	118
Concrete cores drilled	298	Los Angeles abrasion tests	27
Air entraining	416		
Pavers, concrete	8		

During the past fiscal year the Testing Section has tested and inspected samples representing the following approximate quantities of materials:

Material	Quantity
Hot-mix asphaltic concrete	137,730 tons
Central-mix concrete	31,877 cubic yards
Truck-mix concrete	2,221 cubic yards
Job-mix concrete	22,695 cubic yards
Portland cement	85,188 barrels
Reinforced concrete pipe	81,362 lineal feet
Lumber	4,200 board feet
Piling	1,000 lineal feet

Engineers must have knowledge of the physical characteristics of the soils upon which structures will be placed, for use as construction material, as foundations for road surfaces, and for embankments. It is the responsibility of the Soils Section to obtain information of the soils within the areas of proposed construction prior to the design of base courses, pavement, structures, or bridge supports. Soil test reports furnish facts to the designer which allow him to design his structure properly. In addition, soils must be tested in the field to insure that construction specifications relative to quality and compaction are being followed.

The tabulation following represents the tests made by the Soil Section during the year.

Delaware State Highway Laboratory—Before

Delaware State Highway Laboratory—After

Type of Test	Number of Tests
Soil test for design purposes	
Borings, Porter sample (foundations and marsh)	1,971
Borings, deep (supervised)	1,140
Drainage well investigations	15
*Soils surveys (number of feet drilled)	1,967
Soil analysis tests	1,025
CBR determinations (12 field, 31 laboratory)	43
In-place moisture determinations	461
Unconfined compression tests	24
Soil tests for control purposes	
Field moisture tests	597
Field density tests	347
Subgrade pretests	130
Proctor tests	212
Specific gravity tests	29
Hydrometer tests	31
Soil analysis tests	3,931
Borrow pits tested	84

* Soils surveys were conducted for 42 contracts totaling 31 miles.

The addition to the laboratory was completed in March 1961. This addition cost about $140,000 but the improved facilities will more than pay for themselves in the increased efficiency and greater output of the Materials and Research Section.

Maintenance and Equipment Section. The Maintenance and Equipment Section works with the Division Engineers of New Castle, Kent, and Sussex Counties in planning for the future, and assists them in their maintenance responsibilities. The object is to improve and unify maintenance practices, provide proper maintenance equipment on a statewide basis, and utilize manpower and equipment to the best advantage in an emergency.

The Maintenance and Equipment Section engineers, together with the Division Engineers, continually investigate new equipment on the market, carefully choosing pieces which will do a better job, thus reducing man-hours of labor which can be used to better advantage elsewhere. The amount of new equipment acquired this year was limited due to the curtailment of funds and the unusual expenditures

Experiment in chemical weed control. Note the difference in growth of the treated and untreated weeds as indicated by the white posters.

for snow removal. Four contracts, totaling $76,385.69, were let for the purchase of new equipment.

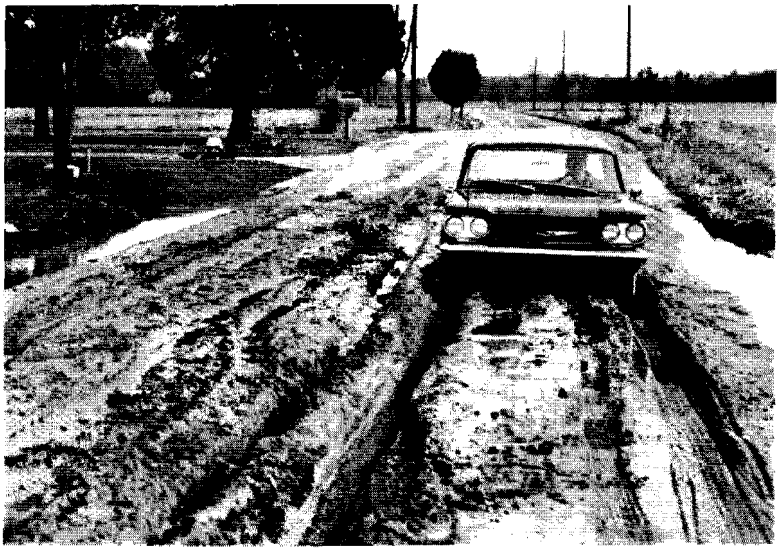
The Maintenance and Equipment Section studies the material needs of the various divisions and assists them in the preparation of contracts for major items; last year 33 proposals were prepared for materials and supplies to be used in the normal course of operations.

This Section continually investigates ways of reducing costs. Investigations and experiments are being conducted with chemical compounds to retard grass growth and objectionable weeds. If the proper compounds can be found the number of mowings per year can be reduced. Similar investigations and experimentation will be conducted relative to many other phases of maintenance work.

ACTIVITIES WITHIN THE COUNTY DIVISIONS

Maintenance. The Division Engineer plans, assigns, supervises, and reviews the maintenance work of the Department in his county. One of his more exacting duties is to maintain good public relations.

Every year the amount of work needed to achieve what is considered to be normal maintenance operations is increas-



Deterioration of dirt road due to spring thaw.

Deterioration of surface-treated road due to prolonged cold weather.

ing. An increase in traffic represents an increase in loadings, which breaks down many pavements. An increase in housing with its concomitant reduction of grass areas increases the amount of runoff, which in turn necessitates recutting ditches and placing more or larger drainage pipe and replacing older pipe which has become obsolete. During the summer it is necessary to repair concrete pavements where blowouts have occurred due to the expansion of the concrete pavement slabs in the summer heat. Crack-filling must be done every fall to preserve the pavement by preventing moisture from reaching the subgrade. Snow fences must be erected to reduce the snowdrift problem. Minor repairs must be made to bridges. Catch basins, pipes, and ditches must be cleaned continually of debris and sediment in order that they may function. Equipment must be maintained in good mechanical condition whether it be a lawnmower or a power shovel. Thus we see that the term "normal maintenance" refers to an almost unlimited list of general tasks.

Weather which deviates greatly from the so-called average creates serious problems in maintenance operations. Hurricanes, exceptional snows and rains, prolonged periods of intense cold all take their toll of roads and budgets. In Delaware the annual seasonal snowfall starts in October, ends in April, and averages about 20 inches. The following table shows the years of the heaviest annual seasonal snowfall above 28 inches.

Snowfall Above 28 Inches

Winter	Inches	Interval
		Years
1909-10	38.0	
1916-17	32.1	7
1917-18	31.9	1
1921-22	35.1	4
1932-33	30.0	9
1933-34	44.7	1
1934-35	35.6	1
1935-36	31.0	1
1940-41	38.1	5
1947-48	35.4	7
1957-58	49.5	10
1960-61	44.1	3

It is impossible to predict when heavy snowfall years will occur. However, light snowfalls with heavy winds or snowfalls within several days of each other can disrupt transportation just as much as a heavier fall. The Main-

"Pushing snow" on US 13.

tenance Sections are equipped to handle the majority of annual snowfalls; however, where exceptional winter accumulations occur which exceed the capability of the Department's equipment to remove the snow quickly, it becomes necessary to hire equipment from contractors. It would be too costly for the Department to purchase enough equipment to guard against extreme conditions because it would be idle most of the time and obsolescence would soon absorb its value, especially when a period of 10 years elapses as it did between the heavy accumulations of 1948 and 1958.

Hurricane "Donna" struck the State on September 12, 1960, with rain and wind velocities up to 104 miles per hour. The kinetic energy in a hurricane is 1,000 times that of the average thunderstorm, and meteorologists estimate that the input energy to an average hurricane may be equivalent to more than 10,000 atomic bombs of the kind that destroyed Nagasaki, Japan. The reason hurricanes do not do more damage is that the energy is distributed over a much larger region. There is no way to predict how often they may come or with what fury they may strike, hence little can be done to prepare for them. Recent improvement in the advance warning systems of the U. S. Weather Bureau does permit

the Department to organize its forces to some degree, after which it is a matter of waiting.

The coastal region of Delaware is very vulnerable to hurricane damage. When "Donna" struck, the highway between Dewey Beach and Bethany Beach was closed to traffic for 3 days to prevent the entry of unauthorized personnel into the damaged housing areas and to enable utility company employees to repair the facilities without the hindrance of spectators. During the storm and for the next 24 hours the entire maintenance force of Sussex County was employed to clear roads and streets of trees and other debris left in the hurricane's wake. The balance of the storm damage, consisting of damaged road surfaces, blocked pipes, and eroded shoulders, required concentrated work for more than a month by all forces to complete repairs. Other hurricanes have been more damaging than "Donna." These have caused breaks in the barrier sand dunes and they have poured torrential rains which no drainage system could handle. When this occurs property damage runs into high figures.

In March 1961, as a result of the prolonged cold weather, probably the worst spring breakup of secondary highways in the history of the Department occurred; at this time there were more low-type roads with surface pavement than ever before. Excessive precipitation and freezing had penetrated deep into the ground and set the stage for the failure of roadway base and surfaces, as a result many miles of highways were damaged to such an extent as to be impassible.

Due to the seriousness of the situation, an immediate survey of the damage was made and it was estimated that $2.5 million would be needed for repairs. Through the cooperation of the General Assembly $1.3 was obtained from the Interstate Highway Division for work the Department had done on approaches to the Delaware Memorial Bridge. This money was spent on immediate repairs.

Nine contracts were let using $750,000 to repair damaged roads and Department-maintained streets in the Wilmington area. The remainder of the funds were set aside to surface-treat badly deteriorated rural roads.

In addition to the above miscellaneous items, special problems for each county are noted below.

In New Castle County, where traffic is the heaviest and suburban growth is most rapid, continual attention to drainage is imperative. All trees and shrubbery in parkways must be sprayed, and dead trees in rights-of-way must be removed.

Mowing grass begins in April and continues through October. Snow fences are erected after October and are removed in April. Bridges require continual maintenance: electric wiring must be replaced, safety gates and safety railings must be repaired, steel decks sometimes need to be rewelded, and marine cables are checked and repaired.

In Kent County dust control in the summer is important. Dirt roads require shaping and widening. Labor, equipment, and dirt required to restore a washed-out road section, caused by hurricane "Donna," cost $16,000. Ninety-two thousand feet of snow fence was purchased.

In Sussex County dust control and dirt roads are important. Here, too, hurricane "Donna" took its toll. This Division has the responsibility of the public or State-owned beaches along the Atlantic Ocean and Delaware Bay. The barrier dunes are continually strengthened against wind and water erosion; beach grasses have been planted and snow fence has proved effective in capturing the wind-driven sand.

The Sussex County Division, in cooperation with the Bridge Section supplies the management and labor to operate and maintain the recreational areas between Rehoboth Beach and Fenwick Island. Funds for this purpose are obtained from the receipts of the Key Box Road tenting area and other concessions. Receipts in 1960 totaled $33,000 as compared with $8,000 in 1957; this shows the increase in the use of these recreational areas.

Construction. During the year New Castle Division had a total of 23 active construction projects under its supervision, the bid prices of which totaled $5,162,585, ranging from emergency patching to all types of road construction, bridge construction, and the construction of the new State Police building at Penny Hill. In addition, 20.28 miles of suburban streets were accepted into the highway system.

In Kent County most of the work consisted of completing contracts awarded in prior years, and the four contracts awarded this year. Six bridges were replaced. Liberty Street in Harrington was rebuilt. The divided highway from Dover to Collins Curve was completed; 31.19 miles of roads were accepted under the dirt road program; work was done on an additional 11.22 miles of dirt roads; and supervision was provided for the construction of the addition to the Testing Laboratory, the new sign shop, and the dam at Coursey's Pond (the latter was done for the State Game and Fish Commission).

US 113, Frederica to Milford, Contract #920.

Stabilizing a dirt road in Sussex County.

In Sussex County 82.6 miles of streets and roads were constructed or reconstructed, new ferry slips were built for the crossing at Woodland, and additions were made to the police station at Bridgeville and Georgetown. The cost of the work completed was $1.8 million.

Freeways Division. The Freeways Division is charged with the responsibilities of performing the construction layout and inspection of all projects relative to Interstate Route 95. The following table indicates the magnitude and schedule of the work.

Contract	Contract Award Date	Work Starting Date	Proposed Completion Date	Acceptance Date	Bid Value
FAI-1(1)	8/22/57	10/ 3/57	11/ 1/58	11/ 5/59	$ 565,872.00
FAI-1(4)	4/14/58	5/ 1/58	8/29/58	5/ 8/58	$ 428,533.74
FAI-1(5)	6/16/58	7/ 3/58	7/21/59	7/14/59	$ 751,153.54
FAI-1(6)	7/16/58	8/20/58	8/20/59	11/13/59	$ 591,887.16
FAI-1(7)	11/17/58	1/ 5/59	5/13/60	9/20/60	$ 390,454.36
FAI-1(8)	6/ 3/59	6/22/59	10/15/60	5/11/60	$ 800,263.39
FAI-1(9)	6/ 3/59	6/22/59	10/15/60	6/20/61	$ 1,670,181.74
FAI-1(10)	12/12/58	1/ 7 59	4/25/60	7/19/60*	$ 1,405,452.25
FAI-1(21-1), FAI-1(23), FAI-1(24)	6/26/61				$12,977,428.99**

* Final inspection was made on June 28, 1961. The steel strike and the severe winter were the main causes for the large deviation from the proposed completion date and the actual acceptance date.

** Note that the contract bid-dollar value of the last contract is almost double the total cost of all construction performed on the Interstate Route to date, and is the largest contract in the history of the Department.

OFFICE ENGINEER

The Office Engineer coordinates the activities of the Special Assignments Section, the Federal-Aid Section, the Hauling Permits Section, and the Outdoor Advertising Section. He also performs liaison among the various divisions and sections on special problems.

Special Assignments Section. The Special Assignments Section deals with problems not handled by others in the Department. These assignments usually are related to highway engineering, the Department in general, and special work the Department is participating in with other State or

The site of US 13 at Farnhurst as it looked in 1915. The view is to the north.

Construction of the Farnhurst Interchange for US 13 and US 95.

Federal agencies. The book *"Delaware Intrastate Water Resources Survey,"* published by the Department on behalf of the State, is a good example of the work done by this section. The survey is the result of collaboration with 28 other State agencies and the U. S. Army Corps of Engineers. So far over a thousand copies of the report have been distributed to interested parties all over the United States, and it is included as Volume VIII of the Corps of Engineers' 11-volume report to Congress on the water resources of the Delaware River Basin. This year the Special Assignments Section and the Director of the Delaware Water Pollution Commission sent to the Corps of Engineers a detailed review of the whole 11-volume report insofar as it relates to Delaware.

This Section also has the task of liaison with the University of Delaware, which is conducting several research projects for the Department. Among these are soil studies of the State, to be shown in a large-scale atlas, hydraulic studies, and work on the stabilization of dirt roads.

Another duty performed by this Section is cooperation with civilian groups interested in roadside beautification, such as the Delaware Roadside Council.

Photography for the Department is supervised by the Special Assignments Section. The various sections of the Department make requests for still or motion picture coverage of their activities, experiments, and research for record or public information purposes. Members of this Section often make photo displays for use in schools and other public centers, as well as showing movies and slides at the request of civic and fraternal groups. The photographic work now includes other tasks such as offset lithographic reproduction of the many forms used by the Department.

Federal-Aid Section. The public advertisement required by State law for the purchase of materials and services is prepared and submitted to the Controller's office for publication. Then bid proposals, consisting of the specifications and all the other papers necessary to provide a valid contract, are assembled and made available to prospective bidders. At the public opening and reading of the bids, representatives of this section record and verify the bids so that a tabulation can be made public. A report is made to the Director of Operations and the Chief Engineer describing the status of each contract for which bids were received.

The use of Federal funds for highways under the various Federal-Aid Highway Acts requires this section to cooperate with the U. S. Bureau of Public Roads. As Federal funds are apportioned to the State, program lists of projects to utilize each class of Federal funds must be submitted to the Bureau. These program lists are prepared on the basis of information supplied by the Planning and Design Division. For each project information must be furnished to the Bureau of Public Roads indicating the type of work (preliminary engineering, acquisition of rights-of-way, construction, etc.), the length of the project, present and future traffic for the facility, the estimated total cost, and the amount of Federal funds requested.

When plans and specifications have been completed by the Planning and Design Division and the project is ready to be advertised for bids, the Federal-Aid Section requests authorization from the Bureau of Public Roads to proceed with advertising for bids. This request is accompanied with copies of the plan, the bid proposal including special provisions, a statement of right-of-way status, town agreements, agreements and cost estimates for utility or railroad work made necessary by the proposed construction, and a detailed itemized preliminary estimate of the project cost. This is precise work and requires close cooperation with the various sections of the Planning and Design Division in order to satisfy Federal requirements.

After the Bureau has concurred in the award of a project to a contractor, a detailed estimate based on contract prices is prepared and submitted to the Bureau with the request that the project agreements be executed, which will allow the State to claim payment for the Federal share of the cost of the project. As work progresses, vouchers are submitted to the Bureau of Public Roads claiming payment for completed work. When a project is complete and accepted by the Department and the Bureau of Public Roads a final voucher is prepared in the same detail as the estimate and submitted for final payment from the Federal Government.

Permit Section. The purpose of the Permit Section is to assist in controlling overwidth and overloaded vehicles on our highways. To this end there are statutory regulations prescribing the weights and sizes of vehicles which can be driven or transported over our highways, the means of transportation, the routes and schedules, and other requirements for special conditions.

A carrier must have a permit in his possession if his vehicle/load combination falls under any of the regulations. A fee is required for each permit and it is scaled to accommodate practically any load which modern living can devise. Overweight vehicles are penalized according to their excess weight and the distance they are to travel, 2¢ per ton per mile being the charge. Nearly $47,000 was collected during the past year.

The control of weights on the roads is important to the longevity of the road. This, in conjunction with the 45-mile-per-hour speed limit for trucks, is designed to make our roads last longer and require less maintenance.

Below is a summary of the permits issued last year for oversize traffic units.

	Permits Issued	Permit Cost	Total Receipts
Heavy hauling	8,262	$ 2.50*	$31,241.63
Piling (30-day permit)	439	12.50	5,481.25
Piling (Single trip)	242	2.50	605.00
Mobile homes	3,401	2.50	8,534.50
Houses and buildings	320	2.50	800.00
Free (State & Federal)	225	...	...
Totals	12,889	...	$46,630.33

* Plus 2¢ per ton per mile for extra weight.

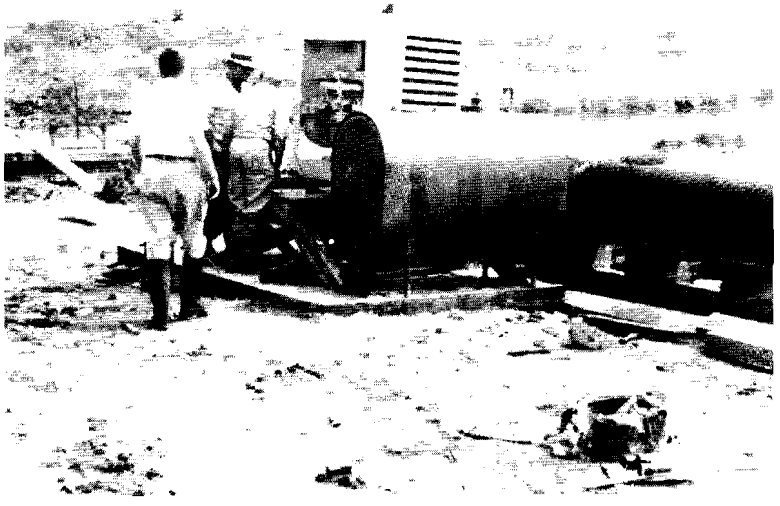
Outdoor Advertising Section. The purpose of this unit is to fulfill the Department's duties in compliance with State and Federal laws relative to the number and type of signs which may be exposed to public view. Safety considerations are incorporated in the regulations to avoid situations which would distract the drivers' attention or would obscure the view at intersections or curves. Roadside beautification is also fostered by the prohibition against unsightly or illegible signs. Detailed regulations concerning outdoor advertising are specified in Chapter 11, Title 17, of the Delaware Code.

During the past year 2,073 new sign permits were issued and a total of $2,271 was collected in fees. The fees are only regulatory and by no means represent the importance of any sign location or the value of the sign itself.

MOSQUITO CONTROL DIVISION

The Mosquito Control Division is responsible for the control and, where possible, the abatement of the mosquito

Aerial view of the water-impoundment area near Little Creek, in Kent County. Note the dikes between the pools.



View of the pump used to regulate the water level in the impoundment area.

nuisance. There are two methods used in mosquito control: aerial spraying for immediate relief, and permanent control work in the breeding areas. Budget restrictions of the past year forced a reduction in operations.

Spraying. This was the second consecutive year in which the Division tried to find a larvicide as a substitute for DDT, which has been used so successfully in former years. Now DDT is less than 50 percent effective because of the resistance developed by the mosquitoes.

Dibrom was tried and found to be highly effective against adult mosquitoes but it was uneconomical to use as a larvicide. A newly-formulated product containing granular Paris green, which other states have found to be effective, it proved to be unsatisfactory at first. Later it was found that the failure was due to the Paris green particles separating from the carrier medium; this has been corrected by increasing the amount of the emulsifier.

The third chemical tried was BHC, so effectively used in the years 1956 through 1958 but to which the mosquitoes developed resistance. After a lapse of two years it was thought the resistance may have diminished, but this was not the case.

Due to the lack of a proper chemical to destroy the larvae, the entire air spray program was directed against the adult mosquito. DDT was used as the toxic agent on the marsh breeding areas and malathion was used on urban and suburban areas.

A total of 230,000 acres was sprayed: 30,000 acres in New Castle County, 103,000 acres in Kent County, and 97,000 acres in Sussex County. The previous year 407,000 acres had been sprayed. Budget restrictions caused a discontinuation of the spray work at the end of August 1960. Continued spraying would have reduced breeding during the following May and June. Fortunately, however, during the month of August and the following spring very favorable weather conditions reduced expected migrations to a minimum. The total expenditure for insecticides, spray oil, and aircraft rental amounted to $89,578.00, or $0.39 per acre.

In addition to aerial work, a fogging machine was used in the resort towns of Sussex County and in Dover. Areas selected were those where heavy foliage precludes effective coverage by aerial spraying.

Permanent Control Work. Resistance developed by the mosquitoes did not affect the permanent control work. During the past year 118,000 feet of 20-inch ditches were constructed and 262,000 feet of ditches were cleaned. Less work was done than in the previous year because of the severe winter weather conditions and the budget restrictions, which limited the number of machine operators and affected the repair of the ditching machines.

Experimentation was conducted in seeking ways to improve the methods of controlling mosquito breeding. Drainage of breeding areas is one of the most effective procedures, and the present tactic is to dig 20-inch ditches 150 feet apart. In October an experimental project was completed involving ditches of 6-, 10-, and 15-foot widths spaced 500 feet apart. This project will be continued for three years to observe the effects of the work on marsh vegetation, water table, and erosion. If this new system of ditching proves to be satisfactory, virtually no maintenance expense will be incurred; those funds will then be available for other purposes.

The second experimental project being conducted on a practical scale is water-impoundment in mosquito-breeding areas near Little Creek in Kent County. A contract was completed on this project in May for diking an area of approximately one square mile so that a sheet of water covers the marsh. Flooding eliminates the breeding areas for the mosquito. Water control structures were installed to regulate the water level so as to encourage plant growth, which is conducive to waterfowl propagation. Observations have proved this to be a very effective method; however, the cost is $100 per acre, or $64,000 per square mile. Unless means are found to reduce the cost, this procedure must be used sparingly.

III. CONCLUSIONS AND RECOMMENDATIONS

This report period coincides with the end of one span and the beginning of another in the history of the State of Delaware and its Highway Department. One can look back and recollect many turbulent periods in the history of the Department, and, for that matter, periods of distress and indecision in road-building generally in our State.

History records many quarrels over the original construction of the du Pont Highway. The right-of-way problems connected with it are almost forgotten in the wake of the growth of the State, but today we still have right-of-way problems facing us as we contemplate the dualization of this same highway where now there exists a 24-foot roadway in the exact center of a 200-foot wide strip of land. The dualization can hardly be accomplished satisfactorily without additional right-of-way.

Political charges beget newspaper headlines about incidents which only history can rationalize. The Penny Hill liquor stories, the Motor Vehicle investigation probes, the Republican "ripper" action in the late thirties and the Democratic counterpart in the fifties have all had their share of attention. And so, another barrage of publicity enveloped the Department under the Attorney General probe of 1960.

The State Highway Department staff personnel, from snowplow operator to maintenance engineer, from survey party rodman to designer, from traffic counter to inspector, all have a continuing responsibility to provide highway facilities for the people in our State and for those who enter it. The tools they need to do the job are varied. Not only a shovel or a bulldozer is necessary, but also adequate salaries, working conditions, legislation, and other related necessities. The following recommendations are intended to help provide the best and most consistent means to allow the individuals who comprise the Department to do a better job for our State.

1. The establishment, by legislative action, of a merit system for State employees.

2. The retention of motor vehicle taxes for the construction, maintenance, planning, and protection of Delaware

highways. It is felt that the establishment of this procedure could be accomplished under a plan which would not only set aside these taxes for the Department, but would also provide that the existing bonds used for road building be paid off from these funds.

3. The establishment of a central administrative office space in the Dover area. Many divisions and sections are now scattered throughout the Dover area, and consolidating these people would provide greater efficiency and eliminate the need to rent several buildings at considerable expense.

4. The establishment of new Division headquarters in New Castle County and in Sussex County. Present facilities are inadequate to do the job which is expected in these areas.

5. Limited access legislation affecting the entire state. At the present time this authority is limited to New Castle County.

6. A means of financing the protection and preservation of the public lands and beaches which are under the jurisdiction of the Department. This could include a fee schedule arrangement for the public land users.